Background Report Reference

AP-42 Section Number: 12.20

Background Chapter: 4

Reference Number: 76

Title: Gravo, Inc., Scrubber Efficiency Evaluation project

November 1989

AP-42 Section 12.20
Reference
Report Sect. 4
Reference 26

AirNova, Inc.

AIR QUALITY SAMPLING AND ANALYSIS

[illegible], Inc.
[illegible] [illegible]

Scrubber Efficiency Evaluation
Project

(609) 858-2100
931 Haddon Avenue
P.O. Box 97
Collingswood, NJ 08108

AP-42 Section 12.20
Reference
Report Sect. 4
Reference 76

Commonwealth of Pennsylvania
Environmental Resources
December 21, 1989

Subject: Stack Test Review

To: Data File
Graveo, Inc.
Chalfont, Bucks County

From: Scott M. Darling
Air Pollution Control Engineer
Continuous Emission Monitoring Unit
Division of Technical Services & Monitoring
Bureau of Air Quality Control

Through: Chief, Continuous Emission Monitoring Unit
Chief, Source Testing & Monitoring Section

The stack tests conducted by Air Nova, Inc. on the scrubber operated by Graveo, Inc. were not compliance tests and were not performed using the Department's reference methods for particulate and chromium. The procedures used should give results indicative of the source's emissions, but could be biased low.

Errors in the calculation of the emission rates were discovered in the test report. The following are the Department calculated results:

Run	1		2	
Pollutant	Particulate	Chromium	Particulate	Chromium
Inlet Concentration (gr./DSCF)	0.0432	0.0019	0.0392	0.00117
Outlet Concentration (gr./DSCF)	0.0046	0.00015	0.0041	0.00012
Inlet Emission Rate (lbs./hr.)	0.2352	0.0103	0.2170	0.0065
Outlet Emission Rate (lbs./hr.)	0.0245	0.0008	0.0216	0.00065
Removal Efficiency (%)	89.9	92.2	90.1	90.0

From Amy

Not enough data

Brian 4/16/96
Can you check to see if this is the entire report.
Thanks Rick
Rick, Heres the rest. Brian 4/16

GRAVCO INC.

November 22, 1989

DER - RECEIVED
NORRISTOWN

NOV 29 1989

Mr. N. Rao Kona
Regional Air Pollution Control Engineer
PA Dept. of Environmental Resources
1875 New Hope Street
Norristown, PA 19401

Re: Plan Approval No. 09-313-069

Dear Mr. Kona:

You were notified on July 25, 1989, that the construction of the double-packed scrubber was completed.

The plan approval does not officially require the outside testing for scrubber efficiency. Gravco had such a test program completed on September 1, 1989, by Air Nova, Inc. The results of these tests for particulate and chromium concentrations emission rates are incorporated in the attached copy of Air Nova's report.

Gravco is volunteering this data to expedite the issuance of a permanent operating permit for the scrubber.

Sincerely yours,

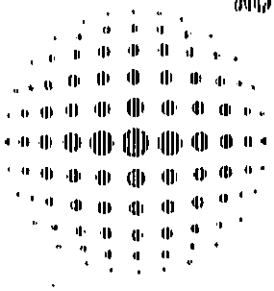
Robert Rand Isen
General Counsel

RI/sc

Enclosure

cc: Mr. Edward Brown, D.E.R.
Jackie Hylton
William Cosden

P.O. BOX 8 ■ CHALFONT, PA ■ 18914 ■ TELEPHONE: (215) 997-3180 ■ FACSIMILE: (215) 997-3185



Arnova, Inc.

AIR QUALITY SAMPLING AND ANALYSIS

[redacted]

Scrubber Efficiency Evaluation
Project

(609) 858-2100
931 Haddon Avenue
P.O. Box 97
Collingswood, NJ 08108

Project No. 1267

GRACE, INC.
Packaged Boiler

Scrubber Efficiency Evaluation
Project

Prepared for:

Bill Condem
WBC Consultants
P. O. Box 372
Beverly, NJ 08010

November 1989

Table of Contents

		Page
1.0	Introduction	1
2.0	Site Description	2
3.0	Results	3

Appendix A - Laboratory Data

Appendix B - Field Data Sheets

Appendix C - Lotus 1-2-3 Calculation Printouts

1.0 Introduction

AirNova, Inc. conducted a scrubber efficiency evaluation project at the GRACO Fairchild Packaging, Inc. facility in Chalfont, Pennsylvania. The on-site testing was conducted on September 1, 1989.

The scrubber was utilized to remove chromium and particulate emissions from the exhaust stream of a chrome plating process. Two (2) simultaneous sampling runs were conducted on the inlet and outlet of the scrubber. Testing was conducted for the following parameters:

Sampling Location	Parameter
Inlet	Particulates Total Chromium
Outlet	Particulates Total Chromium

The removal efficiency of total chromium and particulates was determined from the testing. This report is a summary of the testing project.

2.0 Site Description

The scrubber which was evaluated was designed by Corro-Flow Engineering of Louisville, Kentucky. The counter-current flow scrubber utilized deionized water as the scrubbing solution.

2.1 Process Data

No. of Rollers	4
Length of Rollers	46 inches
Circumference of Rollers	23.5 inches
Application Rate	0.5 micron/min.
Current	2800 amps

Run 1		Run 2	
103.5	G198	103.5	G197
103.5	G203	103.5	G200

3.0 Results

3.1 Air Flows, Temperatures, Moisture Levels

Run	Location	ACFM	Temp. °F	Moisture Level %	DSCFM
1	Inlet	705	89	7.0	634
2	Inlet	719	90	6.7	647
Average		712	90	6.9	641
1	Outlet	672	101	1.1	628
2	Outlet	654	103	0.9	611
Average		663	102	1.0	620

3.2 Particulate Concentrations and Emission Rates

Run	Location	Front Half Concentration grains/dscf	Total Conc. grains/dscf	Front Half Emission Rate lbs/hr	Total Emission lbs/hr
1	Inlet	.046	.047	.019	.019
2	Inlet	.039	.039	.019	.019
Average		.043	.043	.019	.019
1	Outlet	.004	.005	.002	.002
2	Outlet	.001	.002	.001	.001
Average		.003	.004	.002	.002

Standard Conditions: 68°F, 29.92 in. Hg.

3.3 Chromium Concentrations and Emission Rates

Run	Location	Concentration g/dscf	Concentration mg/dscm	Emission Rate lbs/hr
1	Inlet	1.2×10^{-4}	2.0×10^{-6}	0.01
2	Inlet	0.7×10^{-4}	1.1×10^{-6}	0.01
Average		1.0×10^{-4}	1.6×10^{-6}	0.01
1	Outlet	1.0×10^{-6}	1.6×10^{-7}	0.0008
2	Outlet	0.9×10^{-6}	1.4×10^{-7}	0.0007
Average		1.0×10^{-6}	1.5×10^{-7}	0.0008

3.4 Particulate Removal Efficiency (% PRE)

Run	Front Half % PRE	Total % PRE
1	92.1	91.4
2	97.3	96.6
Average	94.7	94.0

3.5 Chromium Removal Efficiency (% CRE)

Run	% CRE
1	92.1
2	88.7
Average	90.4

Standard Conditions: 68°F, 29.92 in. Hg.

Appendix A

Laboratory Data

Graves Emission Evaluation Test
Particulate Laboratory Data

A. Glass Microfibre Filters

Sample I.D	Final mass (g.)	Initial mass (g.)	Net mass (g.)
1-in	0.3377	0.3328	0.0049
2-in	0.3465	0.3435	0.0030
1-out	0.3410	0.3394	0.0016
2-out	0.3569	0.3470	0.0099
Blank	0.3328	0.3332	-0.0004

B. Acetone Front half wash / Back Catch

Sample I.D	Final m. (g.)	Initial m (g.)	Net m. (g.)	Volume (ml)	Aliquot Vol. (ml)
1-in/Ft.	96.458	96.3283	0.1297	110	110
2-in/Ft.	70.8000	70.66	0.1400	187	187
1-in/Bk.	100.8296	100.8283	0.0013	240	100
2-in/Bk.	100.3519	100.3501	0.0018	250	100
1-out/Ft.	92.5391	92.5301	0.0090	110	110
2-out/Ft.	100.8312	100.8283	0.0029	100	100
1-out/Bk.	97.8270	97.8259	0.0011	166	100
2-out/Bk.	95.9984	95.9973	0.0011	182	100
blank	97.8259	97.8259	0	50	50

C. Back half Filtration (.22u)

Sample I.D.	Final m. (g)	Initial (g)	Net m. (g)	Volume (ml)	Aliquot Vol. (ml)
1-in	0.0703	0.0701	0.0002	240	240
2-in	0.0710	0.0707	0.0003	350	350
1-out	0.0717	0.0712	0.0005	154	154
2-out	0.0708	0.0705	0.0003	175	175

Grace Emission Evaluation Test
Chromium Laboratory Data

A. Aqueous Samples

Sample I.D.	Matrix	Aliquot Vol (ml)	Sample Vol. (ml)	Conc. mg/l
1-in	Ft-1/2 acetone	1	113	48.6
1-in	Bk-1/2 DI wash	20	260	< 0.05
2-in	Ft-1/2 acetone	1	188	14.3
2-in	Bk-1/2 DI wash	20	270	< 0.05
1-out	Ft-1/2 acetone	1	131	1.1
1-out	Bk-1/2 DI wash	20	174	< 0.05
2-out	Ft-1/2 acetone	1	122	1.65
2-out	Bk-1/2 DI wash	20	122	< 0.05
blank	DI	20	100	< 0.05
Spike (2-out)	Bk-1/2 DI wash	20 + 5 ml 20 ppm Cr^{+}		11.7 117 % Rec
Control (blank)	DI	20 + 5 ml 20 ppm Cr^{+}		10.8 108 % Rec

B. Glass Microfibre Filters

Sample I.D.	Total ug
1-in	1130
1-out	261
2-in	1530
2-out	229

Appendix B

Field Data Sheets

AirNova, Inc.

PLANT [illegible]
DATE 7/1/[illegible]
SAMPLING LOCATION
SAMPLE TYPE [illegible] Method 5
RUN NUMBER
OPERATOR
BAROMETRIC PRESSURE [illegible]
STATIC PRESSURE
FILTER NUMBER(S)
GEL NUMBER(S)
THIMBLE NUMBER
PLATE NUMBER
H_2O PICKUP (ml)

CO_2
O_2
CO

PYROMETER NUMBER
THERMOCOUPLE NUMBER
PROBE NUMBER
TYPE
NOZZLE NUMBER [illegible]
I.D. 5/16
METER BOX NUMBER [illegible]
$\Delta H_@$
PITOT NUMBER
C_p
SAMPLE BOX NUMBER(S)
ASSUMED MOISTURE (%)
ASSUMED METER TEMPERATURE
C FACTOR
REFERENCE Δp

READ AND RECORD ALL DATA EVERY ______ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
1	06	11:40	757.463	.14	1.3	1.5	103	96	[illegible]	[illegible]	239	[illegible]
2	06	11:46	761.4	.11	1.05	1.05	103	98	95	3.5	239	[illegible]
3	06	11:52	[illegible]	.12	1.15	[illegible]	103	102	97	3.75	247	[illegible]
4	[illegible]	11:58	769.7	.13	1.2	1.2	101	107	[illegible]	3.75	[illegible]	[illegible]
5	06	12:04	773.3	.13	1.2	1.2	101	109	101	3.75	237	109
6	06	12:10	776.2	.13	1.3	1.3	101	110	103	3.75	[illegible]	[illegible]
7	06	12:16	779.8	.14	1.3	[illegible]	102	112	103	3.75	238	102
8	06	12:22	783.8	.13	1.2	1.2	104	110	104	3.75	[illegible]	77
[illegible]	[illegible]	12:28	[illegible]	.12	1.15	1.15	103	111	105	[illegible]	253	97
[illegible]	[illegible]	12:34	791.2	.11	1.05	1.05	[illegible]	111	105	[illegible]	241	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	.11	1.05	[illegible]	101	110	106	3.5	[illegible]	85
12	06	12:46	798.2	[illegible]	.75	.75	98	109	105	2.5	232	[illegible]
		12:52	801.577									

Stack [illegible]

PLANT Paramount DATE 9/1/89 RUN NUMBER 2 ½ PA Particulate 14

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
1	07	13:45	801.713	.11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	07	13:52	805.4	[illegible]	[illegible]	[illegible]	104	[illegible]	103	[illegible]	[illegible]	[illegible]
3	07	13:59	[illegible]	[illegible]	1.15	[illegible]	[illegible]	[illegible]	103	1.25	[illegible]	[illegible]
4	07	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	103	1.24	[illegible]	[illegible]
5	07	14:13	[illegible]	[illegible]	1.2	1.2	[illegible]	105	[illegible]	1.34	[illegible]	[illegible]
6	07	14:19	[illegible]	[illegible]	[illegible]	1.10	102	107	103	[illegible]	254	70
7	07	[illegible]	822.7	[illegible]	[illegible]	1.10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	70
8	07	[illegible]	[illegible]	[illegible]	[illegible]	1.2	[illegible]	102	103	[illegible]	[illegible]	70
9	07	[illegible]	[illegible]	[illegible]	[illegible]	1.15	105	[illegible]	[illegible]	[illegible]	255	71
10	07	14:46	838.672	.12	1.15	1.15	102	110	105	1	254	71
11	07	14:53	842.829	.11	1.05	1.05	102	110	105	1	256	71
12	07	15:00	846.8	.10	.95	.95	101	112	104	1	255	71
[illegible]	07	15:07		.10	.95	.95	103	108	105	[illegible]		
		15:14	854.595									

P_B = 29.5

MOISTURE

IMPINGERS

FINAL VOLUME 171 ml

INITIAL VOLUME 200 ml

NET VOLUME -26 ml

SILICA GEL

FINAL WEIGHT _____ g

INITIAL WEIGHT _____ g

NET WEIGHT _____ g

TOTAL MOISTURE _____ g

ANALYTICAL DATA BY _____

ACETONE FRONT WASH

FINAL _____ mg

TARE _____ mg

NET _____ mg

FILTER NUMBER 1

FINAL _____ mg

TARE _____ mg

NET _____ mg

FILTER NUMBER 2

FINAL _____ mg

TARE _____ mg

NET _____ mg

FILTER NUMBER 3

FINAL _____ mg

TARE _____ mg

NET _____ mg

CYCLONE

FINAL _____ mg

TARE _____ mg

NET _____ mg

TOTAL FRONT _____ mg

ACETONE BACK WASH

FINAL _____ mg

TARE _____ mg

NET _____ mg

ETHER-CHLOROFORM EXTRACT

FINAL _____ mg

TARE _____ mg

NET _____ mg

WATER EVAPORATION

FINAL _____ mg

TARE _____ mg

NET _____ mg

TOTAL BACK _____ mg

I CERTIFY THAT THE SAMPLES DESCRIBED BY THIS DATA SHEET WERE COLLECTED IN ACCORDANCE WITH METHODS OUTLINED BY

I FURTHER CERTIFY THAT THE SAMPLES WERE IN THE POSSESSION OF, OR SEALED FOR SHIPMENT BY COMMON CARRIER BY, MYSELF UNTIL DELIVERY TO A LABORATORY FOR ANALYSIS.

SIGNED _____ DATE ____

WITNESS _____ DATE

I CERTIFY THAT I RECEIVED THE SAMPLES DESCRIBED BY THIS DATA SHEET FROM THE ABOVE NAMED INDIVIDUAL AND ANALYZED THEM IN ACCORDANCE WITH THE ABOVE NAMED PROCEDURE.

SIGNED _____ DATE

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	
AVERAGE METER TEMPERATURE (AMBIENT + 20°F), °F	$T_{m_{AVG.}}$	
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{ws}	
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	
STATIC PRESSURE IN STACK, in. Hg $P_s = \frac{13.6}{}$ x STACK GAUGE PRESSURE in in. H_2O	P_s	
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	
AVERAGE STACK TEMPERATURE, °F	$T_{s_{AVG.}}$	
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta P_{AVG.}$	
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta P_{MAX.}$	
C FACTOR		
CALCULATED NOZZLE DIAMETER, in.		
ACTUAL NOZZLE DIAMETER, in.		
REFERENCE Δ_H, in. H_2O		

DRY MOLECULAR WEIGHT DETERMINATION BY _____

SAMPLING TIME (24-hr CLOCK) _____

SAMPLING LOCATION _____

SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) _____

ANALYTICAL METHOD _____

AMBIENT TEMPERATURE _____

RUN / GAS	1		2		3		AVERAGE DRY VOLUME
	ACTUAL READING	DRY	ACTUAL READING	DRY	ACTUAL READING	DRY	
CO_2							
O_2 (DRY) IF ACTUAL N_2 READING USED ACTUAL CO_2 READING							
CO (DRY) IF ACTUAL CO READING USED ACTUAL O_2 READING							
N_2 (BY DIFF.)							

AirNova, Inc.

PLANT: Paramount Gravco
DATE: 9/1/80
SAMPLING LOCATION: Scrubber Inlet
SAMPLE TYPE: PA Robeck...
RUN NUMBER: 1
OPERATOR: JM / [illegible]
BAROMETRIC PRESSURE: ______ STATIC PRESSURE: ______
FILTER NUMBER(S): ______
GEL NUMBER(S): ______
THIMBLE NUMBER: ______ PLATE NUMBER: ______
H_2O PICKUP (ml): ______

CO_2 ______
O_2 ______
CO ______

PYROMETER NUMBER: ______
THERMOCOUPLE NUMBER: ______
PROBE NUMBER: ______ TYPE: ______
NOZZLE NUMBER: .310 I.D.: .31
METER BOX NUMBER: Nutech 5 $\Delta H_@$: 1.68
PITOT NUMBER: S-type C_p: .8[illegible]
SAMPLE BOX NUMBER(S): N[illegible]
ASSUMED MOISTURE (%): 2
ASSUMED METER TEMPERATURE: 95
C FACTOR: 1.03 REFERENCE Δp: [illegible]

READ AND RECORD ALL DATA EVERY 6 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr clock)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
A-1	00	[illegible]	639.208	.14	1.5	1.5		97	[illegible]	6	[illegible]	57
2	06		643.445	.13	1.4	1.4	88	88	84	6	256	59
3	12		647.684	.14	1.5	1.5	90	92	85	6	259	61
4	18		651.945	.13	1.4	1.4	90	96	[illegible]	6	260	[illegible]
5	24		656.130	.15	1.6	1.6	88	97	88	7	252	63
6	30		660.637	.15	1.6	1.6	87	100	90	7	266	[illegible]
7	36		664.965	.15	1.6	1.6	[illegible]	101	91	7	265	66
8	42		[illegible]1.432	.10	1.1	1.1	76	103	93	5	[illegible]	[illegible]
9	48		673.350	.11	1.2	1.2	72	104	94	5	256	[illegible]
10	54		677.[illegible]	.14	1.5	1.5	72	104	95	6	[illegible]	[illegible]
11	60		[illegible]	.15	1.6	1.6	81	106	96	[illegible]	[illegible]	66
12	66		685.585	.14	1.5	1.5	82	106	97	7	266	66
	72		689.945									

Total: 50.737

PLANT [illegible] DATE 9-1-90 RUN NUMBER [illegible]

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
1	0	1359	691.119	.16	1.7	1.7	96	97	96	7	[illegible]	[illegible]
2	7		695.499	.15	1.4	1.4	88	104	98	6	256	[illegible]
3	14		700.532	.14	1.5	1.5	91	106	99	6	258	[illegible]
4	21		705.579	.15	1.6	1.6	89	107	100	7	253	58
5	28		710.882	.15	1.6	1.6	[illegible]	109	101	[illegible]	252	[illegible]
6	35		716.068	.19	1.5	1.5	90	109	102	6	255	61
7	42		721.209	.11	1.2	1.2	92	110	103	6	256	63
8	49		725.914	.13	1.4	1.4	93	110	103	6	[illegible]	[illegible]
9	56		731.004	.15	1.6	1.6	92	111	103	7	255	65
10	63		736.051	.15	1.6	1.6	91	112	104	7	255	62
11	70		741.304	.14	1.5	1.5	91	112	104	6	257	60
12	77		746.449	.14	1.5	1.5	62	113	105		257	61
	84	1500	751.596									
	Leak ck		@ .004 @ 7	in "								

MOISTURE

IMPINGERS

FINAL VOLUME _____ ml

INITIAL VOLUME _____ ml

NET VOLUME _____ ml

SILICA GEL

FINAL WEIGHT _____ g

INITIAL WEIGHT _____ g

NET WEIGHT _____ g

TOTAL MOISTURE _____ g

ANALYTICAL DATA BY _____

ACETONE FRONT WASH

FINAL _____ mg

TARE _____ mg

NET _____ mg

FILTER NUMBER 1

FINAL _____ mg

TARE _____ mg

NET _____ mg

FILTER NUMBER 2

FINAL _____ mg

TARE _____ mg

NET _____ mg

FILTER NUMBER 3

FINAL _____ mg

TARE _____ mg

NET _____ mg

CYCLONE

FINAL _____ mg

TARE _____ mg

NET _____ mg

TOTAL FRONT _____ mg

ACETONE BACK WASH

FINAL _____ mg

TARE _____ mg

NET _____ mg

ETHER-CHLOROFORM EXTRACT

FINAL _____ mg

TARE _____ mg

NET _____ mg

WATER EVAPORATION

FINAL _____ mg

TARE _____ mg

NET _____ mg

TOTAL BACK _____ mg

I CERTIFY THAT THE SAMPLES DESCRIBED BY THIS DATA SHEET WERE COLLECTED IN ACCORDANCE WITH METHODS OUTLINED BY

I FURTHER CERTIFY THAT THE SAMPLES WERE IN THE POSSESSION OF, OR SEALED FOR SHIPMENT BY COMMON CARRIER BY, MYSELF UNTIL DELIVERY TO A LABORATORY FOR ANALYSIS.

SIGNED _____ DATE ____

WITNESS _____ DATE

I CERTIFY THAT I RECEIVED THE SAMPLES DESCRIBED BY THIS DATA SHEET FROM THE ABOVE NAMED INDIVIDUAL AND ANALYZED THEM IN ACCORDANCE WITH THE ABOVE NAMED PROCEDURE.

SIGNED _____

MULTIPOINT A

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	
AVERAGE METER TEMPERATURE (AMBIENT + 20°F), °F	$T_{m_{AVG.}}$	
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{ws}	
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	
STATIC PRESSURE IN STACK, in. Hg $P_s = \frac{-5.93}{13.6}$ + STACK GAUGE PRESSURE in in. H_2O	P_s	
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	
AVERAGE STACK TEMPERATURE, °F	$T_{s_{AVG.}}$	
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta P_{AVG.}$	
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta P_{MAX.}$	
C FACTOR		
CALCULATED NOZZLE DIAMETER, in.		
ACTUAL NOZZLE DIAMETER, in.		
REFERENCE Δp, in. H_2O		

DRY MOLECULAR WEIGHT DETERMINATION BY _____

SAMPLING TIME (24-hr CLOCK) _____

SAMPLING LOCATION _____

SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) _____

ANALYTICAL METHOD _____

AMBIENT TEMPERATURE _____

RUN / GAS	1		2		3		AVERAGE NET VOLUME
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET	
CO_2							
O_2 (NET = ACTUAL O_2 READING MINUS ACTUAL (CO_2 READING)							
CO (NET = ACTUAL CO READING MINUS ACTUAL O_2 READING)							
N_2 (NET = BALANCE)							

Appendix C

Lotus 1-2-3
Calculation Printouts

Air Nova Inc.

EPA Method 5 Calculations

Plant	Paramount/Gravco project
Project #	1267
Operation	Platen Press No. 2
Run	1
Location	Chalfont, Pa
Date	9/01/89

Scrubber Inlet Test Data

Vlc =	77.6	cc	Vol. of H2O collected (impingers)
Vm =	50.737	cf	Dry gas meter reading
Pb =	30.1	in. Hg	Barometric pressure
Pg =	30.1	in. Hg	Stack pressure
dP =	0.368		Average sq.rt delta P
dH =	1.458	in. H2O	Average draft gauge reading
Tm =	554.25	R	Average meter temperature
Ts =	549.25	R	Average stack temperature
An =	0.001	ft^2	Area of nozzle orifice
Y =	0.99		Meter calibration factor
t =	72	min.	Duration of sampling time
A =	0.5450	sq. ft.	Cross sectional area of stack
Cp =	0.85		Pitot tube coefficient
Kp =	85.49		Pitot tube constant
K1 =	17.64	R/in.Hg	constant
K2 =	0.04707	cu.ft/ml	constant
K3 =	0.002669	in.Hg-cf/ml-R	constant

1) Volume of gas sampled at standard conditions, Vmstd

Vmstd =K1* Y * Vm *(Pb + dH/13.6)/Tm

Vmstd = 48.29 cu.ft

2) Volume of water vapor collected at standard conditions.

Vw(std) = K2 * Vlc

Vw(std) = 3.65 scf

3) Decimal fraction of moisture by volume in stack gas

Bws = Vwstd/(Vmstd+Vwstd)

Bws = 0.070

4) Molecular weight of the stack gas on a dry basis Md.

Ms = (1-0)*((44*%CO2)+(28*%CO)+(32*%O2)+(28*%N2))+(18*0)

Ms = 28.05

Orsat analysis

% CO2	0
% CO	0
% O2	20.3
% N2	79.7

5) Average stack gas velocity.

vs = Kp*Cp*(dP^0.5)*(Ts/Ps*Md)^.5

vs = 21.56 ft/sec

6) Average actual stack gas volumetric flowrate.

Q = 60 * vs * As

Q = 705.08 cfm

7) Average stack gas dry volumetric flowrate.

Qstd = Q * (Tstd/Ts) * (Ps/Pstd)

Qstd = 633.93 cfm

8) Analytical data

a) Front half water wash -insoluble

0 g .22u filter net weight

b) Front half water wash - soluble

0 g filtrate net wt
0 g water blank net wt
0 ml Final wash volume
0 ml aliquot

ERR 0 g soluble net wt

c) Front half acetone wash

0.1397 g wash net wt
0 g acetone blank net wt
110 ml Final wash volume
110 ml aliquot

0.1397 g soluble particulate

d) Front half glass microfibre filter

0.0053 g filter net wt

e) Back half water wash -insoluble

0.0002 g .22u filter net weight

f) Back half water wash - soluble

0.0013 g filtrate net wt
0 g water blank net wt
240 ml Final wash volume
100 ml aliquot

0.0013 g soluble net wt

g) Back half acetone rinse

0 g wash net wt
0 g acetone blank net wt
0 ml Final wash volume
0 ml aliquot

ERR 0 g soluble particulate

9) Total particulate concentrations
mass/dscf

0.0464 grains/dscf Front 1/2 (inc. bk 1/2 insoluble)
0.0468 grains/dscf Total

10) Total particulate emission rate

Conc.*(1 lb/7000 gr)* Qstd *60 min/hr

W = 0.0192 lbs/hr Front 1/2 (inc. bk 1/2 insoluble)
W = 0.0194 lbs/hr Total Particulate

11) Total Chromium concentration
Total Cr= 0.006 g
Conc. = Cr/dscf

Conc. = 0.00012 g/dscf

12) Total Chromium Emission Rate

Conc. * (1/453.6) * Qstd * 60

Wcr = 0.01 lbs/hr

13) Isokineticity

% I = 100*Ts*((K3*Vlc+(Vm*Y/Tm)(Pb+dH/13.6))/(60*t*Ps*vs*An)

% I = 110.06

Scrubber Outlet Test Data

Vlc =	10	cc	Vol. of H2O collected (impingers)
Vm =	44.107	cf	Dry gas meter reading
Pb =	30.1	in. Hg	Barometric pressure
Ps =	30.1	in. Hg	Stack pressure
dP =	0.351		Average sq.rt delta P
dH =	1.159	in. H2O	Average draft gauge reading
Tm =	564.29	R	Average meter temperature
Ts =	551.83	R	Average stack temperature
An =	0.001	ft^2	Area of nozzle orifice
Y =	0.99		Meter calibration factor
t =	72	min.	Duration of sampling time
A =	0.5450	sq. ft.	Cross sectional area of stack
Cp =	0.85		Pitot tube coefficient
Kp =	85.49		Pitot tube constant
K1 =	17.64	R/in.Hg	constant
K2 =	0.04707	cu. ft/ml	constant
K3 =	0.002669	in.Hg-cf/ml-R	constant

14) Volume of gas sampled at standard conditions, Vmstd
Vmstd =K1* Y * Vm *(Pb + dH/13.6)/Tm

Vmstd = 41.20 cu. ft

15) Volume of water vapor collected at standard conditions.

Vw(std) = K2 * Vlc

Vw(std) = 0.4707 scf

16) Decimal fraction of moisture by volume in stack gas

Bws = Vwstd/(Vmstd+Vwstd)

Bws = 0.011

17) Molecular weight of the stack gas on a dry basis Md.

Ms = (1-B)*((44*%CO2)+(28*%CO)+(32*%O2)+(28*%N2))+(18*B)

Ms = 28.69

Orsat analysis

% CO2	0
% CO	0
% O2	20.3
% N2	79.7

18) Average stack gas velocity.

Vs = Kp*Cp*(d2^0.5)*(Ts/Ps*Md)^.5

Vs = 20.55 ft/sec

19) Average actual stack gas volumetric flowrate.

Q = 60 * Vs * As

Q = 678.13 cfm

20) Average stack gas dry volumetric flowrate.

Qstd = Q * (Tstd/Ts) * (Ps/Pstd)

Qstd = 620.28 cfm

21) Analytical data

a) Front half water wash -insoluble

0 g .22u filter net weight

b) Front half water wash - soluble

	0 g	filtrate net wt
	0 g	water blank net wt
	0 ml	Final wash volume
	0 ml	aliquot
ERR	0 g	soluble net wt

c) Front half acetone wash

0.009	g	wash net wt
0	g	acetone blank net wt
110	ml	Final wash volume
110	ml	aliquot
0.009	g	soluble particulate

d) Front half glass microfibre filter

0.002 g filter net wt

e) Back half water wash -insoluble

0.0005 g .22u filter net weight

f) Back half water wash - soluble

0.0011 g	filtrate net wt
0 g	water blank net wt
166 ml	Final wash volume
100 ml	aliquot

0.0011 g soluble net wt

g) Back half acetone rinse

0 g	wash net wt
0 g	acetone blank net wt
0 ml	Final wash volume
0 ml	aliquot

ERR 0 g soluble particulate

22) Total particulate concentrations

mass/dscf

0.00431 grains/dscf	Front 1/2 (inc. bk 1/2 insoluble)
0.00472 grains/dscf	Total

23) Total particulate emission rate

Conc.*(1 lb/7000 gr)* Qstd *60 min/hr

W = 0.00152 lbs/hr	Front 1/2 (inc. bk 1/2 insoluble)
W = 0.00167 lbs/hr	Total Particulate

24) Total Chromium concentration

Total Cr= 0.00041 g

Conc. = Cr/dscf

Conc. = 0.0000100 g/dscf

25) Total Chromium Emission Rate

Conc. * (1/453.6) * Qstd * 60

Wcr = 0.00083 lbs/hr

26) Isokinecity

0.0967 30.19

% I = 100*Ts*(K3*Vlc+(Vm*Y/Tm)(Pb+dH/13.6))/(60*t*Ps*vs*An)

% I = 94.75

2,672.16

27) Scrubber Particulate Removal Efficiency

% RE =100* (Win -Wout)/Win

% RE = 92.08 Front 1/2
% RE = 91.40 Total

28) Scrubber Chromium Removal Efficiency

% RE =100* (Win -Wout)/Win

% RE = 92.06

Air Nova Inc.

EPA-Method 5 Calculations

Plant	Paramount/Bravco project
Project #	1267
Operation	Platen Press No. 2
Run	2
Location	Chalfont, Pa
Date	9/01/89

Scrubber Inlet Test Data

Vlc =	88.2	cc	Vol. of H2O collected (impingers)
Vm =	61.467	cf	Dry gas meter reading
Pb =	30.1	in. Hg	Barometric pressure
Ps =	30.1	in. Hg	Stack pressure
dP =	0.375		Average sq.rt delta P
dH =	1.508	in. H2O	Average draft gauge reading
Tm =	564.5	R	Average meter temperature
Ts =	550.50	R	Average stack temperature
An =	0.001	ft^2	Area of nozzle orifice
Y =	0.99		Meter calibration factor
t =	64	min.	Duration of sampling time
A =	0.5450	sq.ft.	Cross sectional area of stack
Cp =	0.85		Pitot tube coefficient
Kp =	85.49		Pitot tube constant
K1 =	17.64	R/in.Hg	constant
K2 =	0.04707	cu.ft/ml	constant
K3 =	0.002669	in.Hg-cf/ml-R	constant

1) Volume of gas sampled at standard conditions, Vmstd

Vmstd =K1* Y * Vm *(Pb + dH/13.6)/Tm

Vmstd = 57.45 cu.ft

2) Volume of water vapor collected at standard conditions.

Vw(std) = K2 * Vlc

Vw(std) = 4.15 scf

3) Decimal fraction of moisture by volume in stack gas

Bws = Vwstd/(Vmstd+Vwstd)

Bws = 0.067

4) Molecular weight of the stack gas on a dry basis Md....

Ms = (1-G)*((44*%CO2)+(28*%CO)+(32*%O2)+(28*%N2))+(18*G)

Ms = 28.98

Orsat analysis

% CO2	0
% CO	0
% O2	20.3
% N2	79.7

5)Average stack gas velocity.

vs = Kp*Cpe*(dP^0.5)*(Ts/Ps*Md)^.5

vs = 21.98 ft/sec

6) Average actual stack gas volumetric flowrate.

Q = 60 * vs * As

Q = 716.87 cfm

7) Average stack gas dry volumetric flowrate.

Qstd = Q * (Tstd/Ts) * (Ps/Pstd)

Qstd = 646.89 cfm

8) Analytical data

a) Front half water wash -insoluble

0 g .22u filter net weight

b) Front half water wash - soluble

0 g filtrate net wt
0 g water blank net wt
0 ml Final wash volume
0 ml aliquot

ERR 0 g soluble net wt

c) Front half acetone wash

0.14	g	wash net wt
0	g	acetone blank net wt
187	ml	Final wash volume
187	ml	aliquot
0.14	g	soluble particulate

d) Front half glass microfibre filter

0.0034	g	filter net wt

e) Back half water wash -insoluble

0.0003	g	.22u filter net weight

f) Back half water wash - soluble

0.0018	g	filtrate net wt
0	g	water blank net wt
250	ml	Final wash volume
100	ml	aliquot
0.0018	g	soluble net wt

g) Back half acetone rinse

0	g	wash net wt
0	g	acetone blank net wt
0	ml	Final wash volume
0	ml	aliquot
ERR	g	soluble particulate

9) Total particulate concentrations
mass/dscf

0.0386	grains/dscf	Front 1/2 (inc. bk 1/2 insoluble)
0.0391	grains/dscf	Total

10) Total particulate emission rate

Conc.*(1 lb/7000 gr)* Qstd *60 min/hr

W =	0.0190	lbs/hr	Front 1/2 (inc. bk 1/2 insoluble)
W =	0.0192	lbs/hr	Total Particulate

11) Total Chromium concentration

Total Cr= 0.0043 g

Conc. = Cr/dscf

Conc. = 0.00007 g/dscf

12) Total Chromium Emission Rate

Conc. * (1/453.6) * Qstd * 60

Mcr = 0.01 lbs/hr

13) Isokinecity

% I = 100*Ts*((K3*Vlc+(Vm*Y/Tm)(Pb+dH/13.6))/(60*t*Ps*vs*An)

% I = 109.98

Scrubber Outlet Test Data

Vlc =	10	cc	Vol. of H2O collected (impingers)
Vm =	52.83	cf	Dry gas meter reading
Pb =	30.1	in. Hg	Barometric pressure
Ps =	30.1	in. Hg	Stack pressure
dP =	0.341		Average sq.rt delta P
dH =	1.104	in. H2O	Average draft gauge reading
Tm =	565.46	R	Average meter temperature
Ts =	563.25	R	Average stack temperature
An =	0.001	ft^2	Area of nozzle orifice
Y =	0.99		Meter calibration factor
t =	84	min.	Duration of sampling time
A =	0.5450	sq.ft.	Cross sectional area of stack
Cp =	0.85		Pitot tube coefficient
Kp =	85.49		Pitot tube constant
K1 =	17.64	R/in.Hg	constant
K2 =	0.04707	cu.ft/ml	constant
K3 =	0.002669	in.Hg-cf/ml-R	constant

14) Volume of gas sampled at standard conditions, Vmstd
Vmstd =K1* Y * Vm *(Pb + dH/13.6)/Tm

Vmstd = 49.24 cu.ft

15) Volume of water vapor collected at standard conditions.

Vw(std) = K2 * Vlc

Vw(std) = 0.4707 scf

16) Decimal fraction of moisture by volume in stack gas

Bws = Vwstd/(Vmstd+Vwstd)

Bws = 0.009

17) Molecular weight of the stack gas on a dry basis Md.

Ms = (1-B)*((44*%CO2)+(28*%CO)+(32*%O2)+(28*%N2))+(18*B)

Ms = 28.71

Orsat analysis

% CO2	0
% CO	0
% O2	20.3
% N2	79.7

18) Average stack gas velocity.

Vs = Kp*Cp*(dP^0.5)*(Ts/Ps*Md)^.5

Vs = 20.01 ft/sec

19) Average actual stack gas volumetric flowrate.

Q = 60 * Vs * As

Q = 654.32 cfm

20) Average stack gas dry volumetric flowrate.

Qstd = Q * (Tstd/Ts) * (Ps/Pstd)

Qstd = 611.22 cfm

21) Analytical data

a) Front half water wash -insoluble

0 g .22u filter net weight

b) Front half water wash - soluble

0 g	filtrate net wt
0 g	water blank net wt
0 ml	Final wash volume
0 ml	aliquot
ERR	0 g soluble net wt

c) Front half acetone wash

0.0029 g	wash net wt
0 g	acetone blank net wt
100 ml	Final wash volume
100 ml	aliquot

0.0029 g soluble particulate

d) Front half glass microfibre filter

0.0007 g filter net wt

e) Back half water wash - insoluble

0.0003 g .22u filter net weight

f) Back half water wash - soluble

0.0011 g filtrate net wt
0 g water blank net wt
162 ml Final wash volume
100 ml aliquot

0.0011 g soluble net wt

g) Back half acetone rinse

0 g wash net wt
0 g acetone blank net wt
0 ml Final wash volume
0 ml aliquot

ERR 0 g soluble particulate

22) Total particulate concentrations
mass/dscf
0.00122 grains/dscf Front 1/2 (inc. bk 1/2 insoluble)
0.00157 grains/dscf Total

23) Total particulate emission rate

Conc.*(1 lb/7000 gr)* Qstd *60 min/hr

M = 0.00052 lbs/hr Front 1/2 (inc. bk 1/2 insoluble)
M = 0.00066 lbs/hr Total Particulate

24) Total Chromium concentration

Total Cr= 0.00044 g
Conc. = Cr/dscf

Conc. = 0.0000089 g/dscf

25) Total Chromium Emission Rate

Conc. * (1/453.6) * Qstd * 60

Mcr = 0.00072 lbs/hr

26) Isokinecity

% I = 100*Ts*((K3*Vlc+(Vm*Y/Tm)*(Pb+dH/13.6))/(60*t*Ps*Vs*An)

% I = 99.77

27) Scrubber Particulate Removal Efficiency

% RE =100* (Win -Wout)/Win

% RE = 97.29 Front 1/2
% RE = 96.56 Total

28) Scrubber Chromium Removal Efficiency

% RE =100* (Win -Wout)/Win

% RE = 89.72

AirNova, Inc.

Penmount [illegible]
9/11/89
Scrubber Inlet
PA Particulate
1 — JM / FL

[illegible] .310 [illegible] .31
Nutech S [illegible] 1.65
S-type [illegible] .85
Nutech 2
2
98
1.03 [illegible] .27

[illegible] 6 [illegible]

A-1	00	11:36	639.205	.14	1.5	1.5	91	84	83	6	268	57
2	06		643.415	.13	1.4	1.4	88	88	84	6	256	59
3	12		647.657	.14	1.5	1.5	90	92	85	6	258	61
4	18		651.945	.15	1.6	1.6	90	96	87	6	260	62
5	24		656.130	.16	1.6	1.6	86	97	88	7	252	63
6	30		660.537	.15	1.6	1.6	89	100	90	7	256	65
7	36		664.965	.15	1.6	1.6	89	101	91	7	253	66
8	42		669.430	.10	1.1	1.1	96	103	92	5	253	66
9	48		673.330	.11	1.2	1.2	92	103	94	5	256	65
10	54		677.045	.14	1.5	1.5	92	104	95	6	259	65
11	60		681.225	.15	1.6	1.6	89	106	96	7	257	66
12	66		685.585	.14	1.5	1.5	88	106	97	7	256	66
	72		689.945									
			1 Pass ck @ 10" H_2O									
			50.737									

[illegible] Parsons[illegible] [illegible] 9-1-69 [illegible] 2-Pr. Point

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
					[illegible]	[illegible]		[illegible]	[illegible]			
1	0	1339	690.129	.16	1.7	1.7	86	97	96	7	244	54
2	7		695.499	.15	1.4	1.4	88	101	98	6	256	55
3	14		700.632	.14	1.5	1.5	91	106	99	6	258	56
4	21		705.579	.15	1.6	1.6	89	107	100	7	253	58
5	28		710.582	.15	1.6	1.6	90	109	101	7	252	60
6	35		716.068	.14	1.5	1.5	90	109	102	6	255	61
7	42		721.209	.11	1.2	1.2	92	110	103	6	253	63
8	49		725.914	.13	1.4	1.4	93	110	103	6	254	64
9	56		731.004	.15	1.6	1.6	93	111	103	7	255	65
10	63		736.056	.15	1.6	1.6	91	112	104	7	255	62
11	70		741.304	.14	1.5	1.5	91	113	104	6	254	60
12	77		746.499	.14	1.5	1.5	92	113	105		257	61
	84	1503	751.576									

Leak ck at .004 at 15"

FROM

12.13.1999 09:14

P. 2

Stack Sht:

PLANT Paramount DATE 9/1/89 RUN NUMBER Z + PA Particulate 14

P_B = 29.5

Traverse point number	Sampling time, min	Clock time	Gas meter reading	Velocity head	Orifice pressure differential, desired	Orifice pressure differential, actual	Stack temperature	Dry gas meter temperature, inlet	Dry gas meter temperature, outlet	Pump vacuum	Sample box temperature	Impinger temperature
1	07	13:45	801.715	.11	1.05	1.05	104	103	103	1.25	257	73
2	07	13:52	805.9	.10	.95	.95	104	104	103	1.25	244	66
3	07	13:59	809.6	.12	1.15	1.15	109	106	103	1.25	250	66
4	07	14:06	813.8	.13	1.2	1.2	102	106	103	1.25	253	66
5	07	14:13	818.3	.13	1.2	1.2	102	105	102	1.35	253	68
6	07	14:20	822.7	.13	1.45	1.45	104	107	103	1.35	254	70
7	07	14:27	826.9	.14	1.3	1.3	105	109	103	1.35	255	70
8	07	14:34	833.	.12	1.45	1.45	105	109	103	1.35	257	70
9	07	14:46	838.672	.12	1.15	1.15	102	110	105	1	255	71
10	07	14:53	842.889	.11	1.05	1.05	102	110	105	1	254	71
11	07	15:00	846.8	.10	.75	.75	102	110	104	1	256	71
12	07	15:07		.10	.95	.95	103	108	106	1.25	255	71
		15:14	854.545									

Boiler #2 Outlet — Source Testing Review Sheet

Particulate Test

BTU/lb Coal =

lb Coal/hr =

Heat Input =

$V_{m,c}$ (std) = 10

V_m (sample volume) [cf] = 57.830

T_m (°R) (Avg of D_y & Mtr) = 565°R

$P_g = P_{bar} + P_{static}/13.6$ (P_m in H_2O) = 29.88

ΔH = 1.104

C_p = 0.85

K_p = 85.49

T_{stack} (°R) = 563°R

A_N = (Area of Nozzle) [ft²] 0.0052

$V_{wc\ std} = (0.0474)(V_{wc}) =$ [scf] 0.414

$V_{m\ std} = V_m \left(\frac{T_{std}}{T_m}\right)\left(\frac{P_g}{P_{std}}\right) =$ [scf] 53.633

$B_{ws} = \frac{V_{wc\ std}}{V_{m\ std} + V_{wc\ std}} =$ [%] 0.87%

P_{bar} = 29.8 P_{static}

$(\overline{\Delta P})_{avg}$ = 0.341

$A_s = \frac{\pi d^2}{4}$ (#) = 0.595

Θ (Test Time) = 84

W_{pc} [grams] 0.0142 Pre 6
0.00431 Chamber

% CO_2 0.

% O_2 20.3

% ($CO + N_2$) = 1 − (% CO_2 + % O_2) = 79.7

$M_d = .44(\%CO_2) + .32(\%O_2) + .28(\%CO + \%N_2) =$ 28.81

$M_s = M_d(1 - B_{ws}) + 18(B_{ws}) =$ 28.72

$V_s = (K_p)(C_p)(\sqrt{\overline{\Delta P}})_{avg}\sqrt{\frac{T_{stack}}{(P_s)(M_s)}} =$ [ft/sec] 20.09

$Q_s = (A_s)(V_s)(60) =$ [cfm] 656.5

$Q_{s\ std} = Q_s\left(\frac{T_{std}}{T_s}\right)\left(\frac{P_s}{P_{std}}\right)(1 - B_{ws}) =$ [Dscf] 611.6

$V_{s\ std} = \frac{Q_{s\ std}}{A_s} =$ [Fe/min] 1122.7

C_s (Conc) = $(W_{pc})(35.43)/(V_{m\ std}) =$ (g/dscf) 0.00401 Pre 6 Chem.

P_{pc} (Pound Pre. / hr) = $(W_{pc})(Q_{s\ std})(60)/(V_{m\ std})(454)$ = 0.00912 Pre 6
0.00065 Chem.
0.0234 Pre

% $I_{Sokinetic} = \frac{V_{m\ std}}{(A_N)(\Theta)(V_{s\ std})} \times 100\%$ 109%

lb Pre/MM BTU = $\frac{P_{pc}}{\text{Heat Input}} =$

ALLOWABLE = lb/MMBTU

Run #2 Inlet

Source Testing Review Sheet
Particulate Test

BTU/lb Coal =
lb Coal/hr =
Heat Input =

V_{H_2O} (ml) = 88.2

P_{bar} = 29.8 P_{static} =

V_m (sample volume) [cF] = 61.467

$(\sqrt{\Delta P})_{ave}$ = 0.3749

T_m (°R) (Temp of Dry Gas Meter) = 565°R

$A_s = \frac{\pi d^2}{4}$ (ft²) = 0.545

$P_s = P_{bar} + P_{static}/13.6$ (in Hg) = 29.91

Θ (Test Time) = 84

ΔH = 1.508

W_{Part} = [grams] 0.1450 Part
0.004319 Chromium

C_p = 0.84

% CO_2 0

K_p = 85.49

% O_2 20.3

T_{stack} (°R) = 551°R

%(CO + N_2) = 1 − (% CO_2 + % O_2) = 79.7

A_N = (Area of Nozzle) = [ft²] 0.00052

$V_{H_2O\ std} = (0.0474)(V_{H_2O})$ = [scF] 4.1807

$V_{m\ std} = V_m \left(\frac{T_{std}}{T_m}\right)\left(\frac{P_s}{P_{std}}\right)$ = [scF] 57.064

$B_{wo} = \frac{V_{H_2O\ std}}{V_{m\ std} + V_{H_2O\ std}}$ = [%] 6.83%

M_d = .44 (% CO_2) + .32 (% O_2) + .28 (% CO + % N_2) = 28.81

$M_s = M_d (1 - B_{wo}) + 18 (B_{wo})$ = 28.07

$V_s = (K_p)(C_p)(\sqrt{\Delta P})_{ave} \sqrt{\frac{T_{stack}}{(P_s)(M_s)}}$ = [ft/sec] 22.07

$Q_s = (A_s)(V_s)(60)$ = [cFM] 721.7

$Q_{s\ std} = Q_s \left(\frac{T_{std}}{T_s}\right)\left(\frac{P_s}{P_{std}}\right)(1 - B_{wo})$ = [DScF] 696.5

$V_{s\ std} = \frac{Q_{s\ std}}{A_s}$ = [Ft/min] 1278.3

C_s (Conc) = $(W_{part})(15.43)/(V_{m\ std})$ = (g/dscF) 0.0392 Part
0.00117 Chromium

P_{part} (Pound Part./hr) = $(W_{part})(Q_{s\ std})(60) / (V_{m\ std})(454)$ = 0.217 Part
0.0065 Chr

% Isokinetic = $\frac{V_{m\ std}}{(A_N)(\Theta)(V_{s\ std})}$ × 100% 110 %

lb Part/MM BTU = $\frac{P_{part}}{heat\ input}$ =

ALLOWABLE = lb/MMBTU

Unit Source Testing Review Sheet
Particulate Test

BTU/lb Coal =
lb Coal/hr =
Heat Input =

V_{H_2O} (Cnd) = 77.6
V_m (sample volume) [cF] = 50.937
T_m (°R) (Avg of Dry Gas Meter) = 554 °R
$P_g = P_{bar} + P_{static}/13.6$ (in Hg) = 29.91
ΔH = 1.456
C_p = .85
K_p = 85.49
T_{std} (°R) = 549
A_N = (Area of Nozzle) = [ft²] 1.2887 0.00892
$V_{H_2O\ std} = (0.0474)(V_{H_2O})$ = [scf] 3.677
$V_{m\ std} = V_m \left(\frac{T_{std}}{T_m}\right)\left(\frac{P_g}{P_{std}}\right)$ = [scf] 49.523
$B_{ws} = \frac{V_{H_2O\ std}}{V_{m\ std} + V_{H_2O\ std}}$ = [%] 7.04

P_{bar} = 29.8 P_{static} =
$(\Delta P)_{avg}$ = 0.3679
$A_s = \frac{\pi d^2}{4}(4)$ = .895
θ (Test Time) = 72
W_{Part} [Grams] 0.1361 gm. Part.
0.00594 gm. Chromium
% CO_2 10
% O_2 20.3
% ($CO + N_2$) = 1 − (% CO_2 + % O_2) =

$M_d = .44(\%\ CO_2) + .32(\%\ O_2) + .28(\%\ CO + \%\ N_2)$ = 28.81
$M_s = M_d(1 - B_{ws}) + 18(B_{ws})$ = 28.05
$V_s = (K_p)(C_p)(\sqrt{\Delta P})_{avg}\sqrt{\frac{T_{stack}}{(P_s)(M_s)}}$ = [ft/sec] 21.62

$Q_s = (A_s)(V_s)(60)$ = [cfm] 707.2
$Q_{s\ std} = Q_s\left(\frac{T_{std}}{T_s}\right)\left(\frac{P_g}{P_{std}}\right)(1 - B_{ws})$ = [Dscf] 634.4
$V_{s\ std} = \frac{Q_{s\ std}}{A_s}$ = [Fpm] 1169.06
C_s (Conc) = $(W_{part})(15.43)/(V_{m\ std})$ = (g/dscf) = 0.0032 grains/dscf Part
0.0014 grains/dscf Chromium
P_{part} (Pound Part/hr) = $(W_{part})(Q_{s\ std})(60)/(V_{m\ std})(454)$ = 0.2352 #/hr

0.003#/hr Chromium

$\%\ Isokinetic = \frac{V_{m\ std}}{(A_N)(\theta)(V_{s\ std})} \times 100\%$ = 52.7%

111.3%

lb Part/MMBTU = $\frac{P_{part}}{Heat\ Input}$ =

ALLOWABLE = lb/MMBTU

Run 1 Onsite Source Testing Review Sheet

Particulate Test

BTU/lb Coal =

lb Coal/hr =

Heat Input =

V_{m_0} (cal) = 10

V_m (sample volume) [cF] = 44.107

T_m (°R) (Temp. of Dry Gas Meter) = 5692

$P_g = P_{bar} + P_{static}/13.6$ (P_m / P_s) = 29.89

ΔH = 1.158

C_p = .85

K_p = 85.49

T_{stack} (°R) = 5672

P_{bar} = 29.9 P_{static} = -.19

$(\Delta P)_{ave}$ = .3507

$A_s = \frac{\pi d^2}{4}$ (4) = 0.545

Θ (Test Time) =

W_{pre} [grams] 0.0122 → Part.
0.000406 = Chromium

% CO_2 0

% O_2 20.3

%($CO + N_2$) = 1 − (%CO_2 + %O_2) = 79.7

$A_N = (A_{no.}$ of Nozzle) · [ft²] Conf-FP 0.0055

$V_{H_2O\ std} = (0.0494)(V_{H_2O}) =$ [scf] 0.674

$V_{m\ std} = V_m \left(\frac{T_{std}}{T_m}\right)\left(\frac{P_s}{P_{std}}\right) =$ [scf] 41.396

$B_{ws} = \frac{V_{H_2O\ std}}{V_{m\ std} + V_{H_2O\ std}} =$ [%] 1.6%

$M_d = .44(\%CO_2) + .32(\%O_2) + .28(\%CO + \%N_2) = 29.81$

$M_s = M_d(1 - B_{ws}) + 18(B_{ws}) = 28.69$

$V_s = (K_p)(C_p)(\sqrt{\Delta P})_{ave}\sqrt{\frac{T_{stack}}{(P_s)(M_s)}} =$ [ft/sec] 20.68

$Q_s = (A_s)(V_s)(60) =$ [cfm] 675.41

$Q_{s\ std} = Q_s\left(\frac{T_{std}}{T_s}\right)\left(\frac{P_s}{P_{std}}\right)(1 - B_{ws}) =$ [Dscf] 621.7

$V_{s\ std} = \frac{Q_{s\ std}}{A_s} =$ [Ft/min]

C_s (Conc.) = $(W_{part})(15.43)/(V_{m\ std}) =$ (g/dscf) 0.0096 g/dscf → Part.
0.0005 g/dscf Chrome ↓

P_{part} (Part. Rem./hr) = $(W_{part})(Q_{s\ std})(60)/(V_{m\ std})(454) =$ 0.0225#

Where (2.00%) = #/hr.

0.0005 #/hr ↓ Chromium

% Isokinetic = $\frac{V_{m\ std}}{(A_N)(\Theta)(V_{s\ std})} \times 100\% =$ 94.7%

95.6

lb Part/MMBTU = $\frac{P_{part}}{Heat\ Input} =$

ALLOWABLE = lb/MMBTU